prevailed over the region about Washington, while the cloud motion would seem to indicate a rapid movement of the upper currents toward the center of the depression over the Gulf of St. Lawrence.

The formation of billow clouds has been explained by various persons: Professor Cleveland Abbe, in this country; the Reverend Clement Ley, in England; Professor H. von Helmholtz, and Dr. von Bezold, in Germany, and doubtless others.

So far as observed, wave clouds have no particular significance, in this country at least, although Dr. Kassner, of Berlin, is of opinion that in many cases they are an indication of precipitation. (Meteorologische Zeitschrift, 1894, p. 434.)

NOTES BY THE EDITOR.

THE WEIGHT OR MASS OF THE ATMOSPHERE.

A correspondent has recently asked for "the computed weights of the earth and of the atmosphere." The weight of any mass as ordinarily determined is frequently confounded with the mass itself, whereas it is strictly speaking a special property of the mass. We use a standard piece of metal called a "pound weight" and balance that against any other object, and say that the latter weighs a pound; we mean that the latter has the same mass as that of the pound weight. In doing this we assume that the same force of gravity acts upon the object and the standard weight, and that too in exact proportion to their masses. If, on the other hand, the force of gravity acts with less intensity on the object than on the standard weight then the fact that they counterbalance each other would tell us nothing about the relative masses.

As the reply to our correspondent may be helpful to others, and illustrates a principle that is important in meteorology, we have revised the figures originally communicated to him and submit the following:

(1). *The computed weight of the earth.*—The weight of any mass depends upon the force of gravity and can, therefore, not be stated except for some definite locality. The standard value of gravity is usually assumed to be that which prevails on the earth's surface at 45° latitude and sea level. At this place a pound of water considered as a mass has a weight or produces a pressure of one standard pound considered as a weight or pressure. A cubic foot of water at this place will weigh about 62.5 pounds, and a cubic foot of the average earth will weigh about 343.75 pounds, because the average density of the whole earth has been determined to be about 5.5 times the density of water. The whole earth, if it were compressed into so small a space that this standard gravity could act uniformly on it, would, therefore, at this place weigh as many pounds as the product of 343.75 multiplied by the volume of the earth expressed in cubic feet. This volume, as given by Woodward's Smithsonian Tables, page LXV, is 259,880,000,000 cubic miles, and a cubic mile contains $5,280 \times 5,280 \times 5,280$ cubic feet.

Latitude.	Mean pressure at sea level.	Cosine latitude.	Latitude.	Mean pressure at sea level.	Cosine latitude.	Latitude.	Mean pressure at sea level.	Cosine latitude.
°	*Inches.*		°	*Inches.*		°	*Inches.*	
N. 90	29.95?	0.0000	25	29.94	0.9063	35	30.02	0.8191
85	29.95?	0.0872	20	29.89	0.9397	40	29.94	0.7660
80	29.94	0.1738	15	29.85	0.9659	45	29.82	0.7071
75	29.92	0.2588	10	29.84	0.9848	50	29.65	0.6428
70	29.87	0.3420	N. 5	29.84	0.9961	55	29.46	0.5736
65	29.85	0.4226	0	29.84	1.0000	60	29.27	0.5000
60	29.87	0.5000	S. 5	29.85	0.9961	65	29.12	0.4226
55	29.91	0.5736	10	29.89	0.9848	70	29.06	0.3420
50	29.95	0.6438	15	29.93	0.9659	75	28.98?	0.2588
45	29.98	0.7071	20	29.99	0.9397	80	28.92?	0.1737
40	30.00	0.7660	25	30.05	0.9063	85	28.89?	0.0872
35	30.02	0.8192	30	30.06	0.8660	S. 90	28.87?	0.0000
30	29.99	0.8660						

The above gives the exact arithmetical data needed for computing the weight of the earth. The result is 13,150 followed by 21 figures, or $13,150 \times 10^{21}$. This computed weight refers to the solid and liquid earth, and does not include the atmosphere.

(2). *The computed weight of the atmosphere.*—The atmosphere covers the earth in a very unequal layer, so that even at sea level in some places the pressure is as high as 31 barometric inches, and in other places is not higher than 29. From careful measurements on Buchan's charts of the mean annual pressure over the whole globe, Ferrel found that the average air pressure at sea level for each zone of latitude is about as given in the preceding table. (See Ferrel's "Contributions to Meteorology," No. 1, p. 400, or Waldo's "Elementary Meteorology," p. 96). The figures here marked with a query are supplied by extrapolation, and are slightly less reliable than the others.

Buchan's charts give the pressure as measured by a mercurial barometer reduced to standard temperature and gravity and sea level, they, therefore, assume air to be present where the continents and islands protrude above the ocean.

The figures in the accompanying table mean that at sea level the average weight of a column of air extending from that level up to the top of the gaseous atmosphere is balanced by or equivalent to the weight of a column of mercury of standard density, having a height of 29 or 30 inches, and pulled downward by the standard force of gravity at 45° and sea level, which force is that which gives the mercury its weight. We ordinarily say that the pressure of the atmosphere is about 15 pounds to the square inch, this is because a column of mercury 30 inches high and one square inch in section weighs about 15 pounds, but this is not exactly the weight of the column of air that has one square inch in section and reaches up to the top of the atmosphere. We have simply balanced the sea-level pressure of the air by the pressure or weight of a mercurial column which is under the influence of standard gravity, although the greater part of the air is under a slightly diminished gravity. But as in the previous section we weighed the earth under standard gravity so we also must do for the atmosphere; it must be imagined to be compressed into a small bulk and weighed at the same level as the mercury.

The ordinary barometric measurement, in which a tall column of atmosphere balances a short column of mercury, reminds one of a very refined method of determining the absolute value of the force of gravity. In this method one weight is suspended by a long wire, the other by a short one. The two weights balance each other perfectly when the wires are of equal length, but imperfectly if one weight is nearer to the earth than the other. The lower weight is said to weigh more than the other one, although they both have the same mass precisely.

A column of atmosphere many miles high, balanced by 30 inches of mercury at sea level, would counterbalance at least 30.06 inches if it were all brought down to the region where standard gravity prevails, or, in other words, the pressure of this column of air would be increased by two one-thousandths of itself.

The second column of the preceding table will give the average pressure at sea level for the whole atmosphere by making proper allowance for the diminution of the circles of latitude as we approach the poles; the circumferences are proportional to the cosine of the latitude, as given in the third column. The resulting average pressure is 29.84 for the whole globe, being 29.910 for the northern and 29.774 for the southern hemispheres respectively. If we increase these figures by 0.06, we shall make an approximate allowance for the diminution of gravity with altitude. On the other hand, there is a slight diminution of this computed mass, amounting to about one per cent, owing to the fact that we have assumed air to exist where the continents really are.

The problem, therefore, resolves itself into this. The average pressure to be used is about 29.90 inches, or 2.492 feet of mercury. A cubic foot of mercury weighs about 848 pounds, therefore, the weight of the atmosphere above any square foot of the earth's surface is 2,117 pounds. If we multiply this by the area of the globe in square feet, we get the total weight of the atmosphere. According to Woodward's Smithsonian Tables, page LXV, this area is 198,940,000 square miles, and each square mile is $5,280 \times 5,280$ square feet. The result is 10,392 followed by fifteen figures, or $10,392 \times 10^{15}$.

The mass of the atmosphere is therefore so small a fraction of that of the solid earth that it is represented by $\frac{1}{1125000}$ or about one one millionth.

The preceding value is the lower limit of the mass of the atmosphere. Our knowledge of the physical and mechanical conditions existing in the upper air is so unsettled at present that, according to Prof. R. S. Woodward, there is a possibility that there may be nearly 1,000 times as much air belonging to our atmosphere.

THE WEATHER BUREAU IN ALASKA.

The Chief of Bureau has issued orders transferring the central station of the Alaskan section of the Climate and Crop Service from Sitka to Eagle on the Yukon near the British line. Mr. H. L. Ball, the section director at Sitka, will return to the States, and the work in Alaska will be placed in the charge of Mr. U. G. Myers, who has been connected with the Weather Bureau for a number of years, and for the past twelve months has been in the region in which the new central station will be located. Owing to poor facilities for communication Mr. Ball found it impracticable to establish stations at interior points, and it is believed that by the change that has been ordered it will be possible to establish a number of stations in the upper Yukon region, from which it has been heretofore impossible to procure meteorological observations. The Bureau has already in its possession records covering several years of observations at Sitka, and also at other stations in the coast region, but at points far in the interior it has been almost wholly impossible to secure observations, although numerous efforts in that direction have been made. Mr. Myers' residence of the past twelve months in Alaska, and his determination to remain in that territory for some years to come, encourages the Chief of the Weather Bureau to believe that in the next few years most valuable information will be obtained concerning the climate of this region, of which so little is at present known. While the value of the observations at Eagle alone will amply justify the change that has been ordered, it is expected that Mr. Myers, with headquarters at Eagle, will be able to establish a number of voluntary stations at hitherto inaccessible places in the interior. Mr. Myers is a resolute and courageous young man, possessing mental and physical qualifications which especially fit him for the arduous duties and hardships involved in a residence in this inhospitable region. The station at Sitka will be maintained under Prof. C. C. Georgeson, who has charge of the agricultural experiment work in Alaska. Professor Georgeson will also have his assistants conduct meteorological observations at various points, at which they may be located in the prosecution of the experimental work under their charge.

SOLAR HALO.

Mr. James Hyatt, of Stanfordville, Duchess County, N. Y., reports a halo seen February 1, 1899, between 3 and 3:30 p. m., eastern standard time, consisting of an arc of prismatic colors, and convex to the sun, distant 46° from it and subtending an angle of about 50°. There were no other attending fragments of a halo and no parhelia.

It is rather rare that one observes this portion of a halo without any attending portions, but it is by no means unknown. The occurrence depends upon a rather rare combination of temperature and the altitude of the sun. This halo can only be formed when the sun's rays pass through crystalline needles of ice that are slowly descending through the atmosphere. The rays must enter the prism through faces or facets that are inclined to each other at an angle of 54° 44′. In higher latitudes, where halos frequently occur, the sun is generally so low down that a great variety of halo phenomena can be seen; but in these southern latitudes, when the ice needles are favorably located in the air, the sun is so high up that we see only the upper portion of the halo. On February 13, 1895, between 8:45 and 9:15 a. m., a similar phenomenon was seen at Washington, which is described and explained at page 56 of the MONTHLY WEATHER REVIEW for that date.

FREQUENCY OF INJURIOUS PHENOMENA.

A correspondent at Beaufort, S. C., says:

Why do we now have disastrous cyclones in this neighborhood about every two years, whereas twenty-five years ago they were of rare occurrence? And, again, why do we now have unusually severe cold spells, whereas formerly it was only at long intervals that orange trees were killed by cold snaps? Are not these changes due to the destruction of forests in the northwest?

The answers to these questions may interest many of our readers and are about as follows:

(*a*) The destruction of forests in "the northwest," no matter whether this term refers to the Appalachian Range or the Ohio Valley and Michigan, or Wisconsin and Lake Superior, or the Rocky Mountain region, or the Pacific Coast States, can not have had any appreciable influence upon the climate of the coast of South Carolina.

(*b*) An examination of the records that are available for study, during the past hundred years, shows that there has been no remarkable increase in the number of either cyclones or cold spells. The word "cyclone" is evidently used by our correspondent in the sense of an extensive storm, similar to the West Indian hurricanes, and not in the sense used in the Western States, where it has unfortunately been misapplied to the tornado.

(*c*) The atmosphere of the whole globe is everywhere subject to irregular variations, as well as to regular daily and annual variations in its temperature, moisture, winds, and storms. These irregular variations do not appear to depend directly upon anything outside of the air, such as the sun and moon above us, the changes produced by man on the surface of the earth below. They are as peculiar to and inherent in the atmosphere as the currents and ebullitions in a pot of boiling water or the eddies in a river during a flood are peculiar to those fluids. The cause and probable continuance of any unusual frequency of storms or frosts can not at present be definitely stated. If the records of these phenomena were precise and definite and extended over many years, for any given locality, we could calculate the probability that two or more would accidentally occur within a short period of time. Such computations have been made for other places, and have shown that there is no reason to think that a rare combination of years of disastrous meteorological phenomena will recur more than two or three times in a century.